National Aeronautics and Space Administration

Light but **Strong**

A Lesson in Engineering

engineering is out of this world

EP-2013-09-107-MSFC

Light but **Strong**

teacher notes

Next Generation Science Standards:

Structure and Properties of Matter

2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

5-PS1-3. Make observations and measurements to identify materials based on their properties.

Engineering Design

K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

3-5-ETS1-1. Define a simple problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Materials (per group):

- Plastic drinking straws (30)
- Scissors (1 pair)
- Pennies (20)
- One small paper or Styrofoam cup
- One 3” by 3” piece of cardboard
- Balance scale (optional)
- Various materials such as clay, tape (recommended for younger students), or playdough to connect the straws together.

Carolyn Russell — In the words of an engineer: “Materials engineering is a diverse, challenging field of study because everything in the world is made from different materials, each having specific characteristics. To develop a new rocket, NASA materials engineers must first choose, then test the materials, to ensure the rocket is strong and light weight so that building can begin.”

An Introduction to Materials Engineering

Lesson Duration: 1 hour

The Challenge

Design and build a mobile launcher platform that is light enough to be moved to the launch pad, but strong enough to hold the weight of the rocket.

1. Be prepared

- Read the teacher notes and student journal page.
- Gather materials for the activity listed on the teacher notes page.
- Count the straws ahead of time for each group.
- Draw a spacecraft on the side of the small cup to represent the crew vehicle.

2. Background information on materials engineering

Materials engineers are involved in the development, processing, and testing of the materials used to create a range of products. A materials engineer at NASA would develop lightweight, strong, heat resistant materials for use in space.

3. Introduce the challenge (5 minutes)

- Students should develop an understanding of the word ***material.***

A material is a substance out of which a thing is or can be made. Choose an object in your classroom and hold it up in front of the class. Ask the class what materials make up the object. (Example: a pencil is made of wood, lead, metal, and rubber for the eraser.) Do this several times with different objects until the students understand the word material.

- **Discuss with the class what the role of a materials engineer is at NASA.**

  A materials engineer selects the materials to build rockets, spacecrafts, and launch pads. Sometimes they have to make new materials to meet the needs of the rocket. Read Carolyn Russell's description of a materials engineer to the class. Show the class pictures of the Space Launch System (SLS) rockets.

- **Introduce the activity to the students.**

  Tell your students they have been challenged by a NASA materials engineer to use a lightweight material to build a mobile launcher platform that can be light enough to move, but also strong enough to hold the weight of the rocket. The students should brainstorm ideas, design the launcher platform, and evaluate how well the launch pad held the weight of the astronauts (pennies). Put students into groups of 3-5 to build the platform.

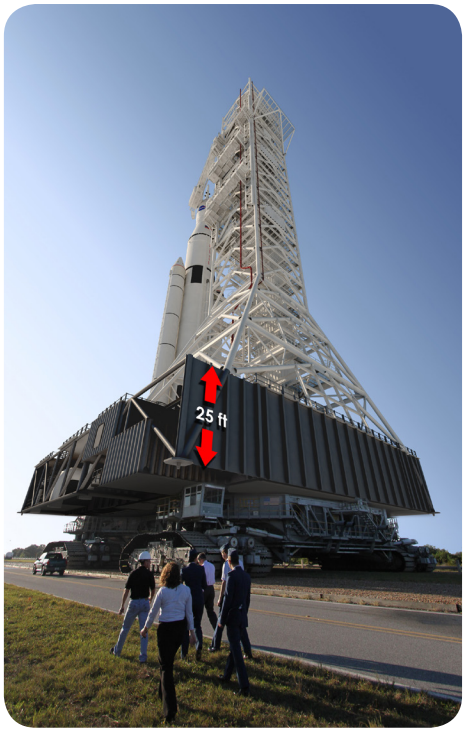
  Students will build a mobile launcher platform that will be light, but also strong enough to hold the weight of the astronauts (pennies) in the cup (rocket) that sits on top of the launcher platform. The platforms should be built with straws and a material such as tape or clay to hold the platform together.

  After each group completes their mobile launcher platform, set a 3" by 3" piece of cardboard on top of the launcher platform with a cup sitting on top and drop one penny at a time into the cup (rocket) to test the strength of the platform until the platform collapses. Explain that mobile launcher platforms have to be light enough to roll out to the launch site, but also strong enough to hold the weight of a rocket and crew. The SLS 70-metric ton rocket will weigh 5.5 million pounds. The 130-metric ton rocket will weigh 6.5 million rocket.

4. Think it over and design (15 minutes)

- Distribute the challenge instructions and journal page to each student.
- What kind of mobile launcher platform can you make from the supplies provided? (Straws can serve as the walls of the platform. The tape or clay could be used to hold the straws together.)

If you use clay to build the platform, place a sheet of paper on the table for them to build the platform on. If the straws are too flexible, cut them in half.



The Mobile Launcher Platform (MLP) at Kennedy Space Center was originally constructed for transporting the Saturn V rocket. The base alone is 25-feet high.

Change it up!

There are many ways to enhance the activity!

- Choose a height or weight goal for the platform.
- Have different groups use different materials to build the platform and compare.
- Require a hole in the center of the launch pad for the rocket "flame."
- Have the students make their own material using a recipe for homemade play dough. Recipes can be found online.

Light but **Strong**

NASA materials engineer Carolyn Russell inspects sample weld plugs on a piece of light weight aluminum.

- Instruct students to answer the questions on the journal page about two items that they think are light but strong. (Examples: aluminum, cardboard, plastic, and more)
- Have the students get together with their assigned groups and discuss how they will build their mobile launcher platform. Have each student draw a picture of the group's proposed mobile launcher platform on their individual journal page.

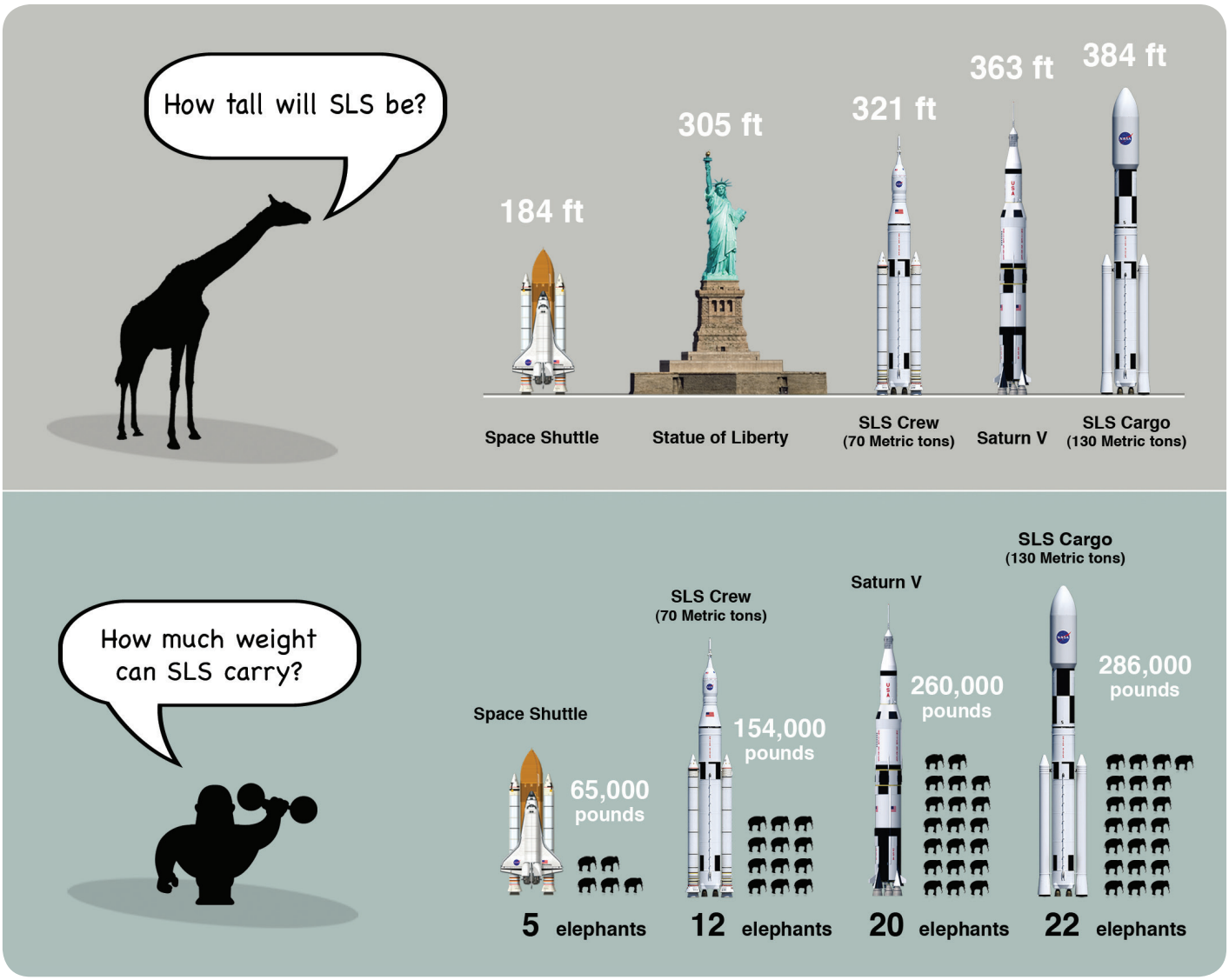
5. Build and test (30 minutes)

- Distribute materials to the groups.
- Explain that each group's mobile launcher platform will be tested by placing a 3" by 3" piece of cardboard on top of the platform. A cup representing the rocket will be placed on the cardboard. One penny at a time will be placed in the cup to see how much weight the mobile launcher platform will hold. The platform must be 6" high. Give each group 20–30 minutes to build their platform.

6. Discuss activity (10 minutes)

- Have the students share how they designed their mobile launcher platform and the results.
- What features helped your platform withstand the weight of the pennies?
- Would you make any changes if you could rebuild the platform?
- Did any materials work better than others?

SLS FUN FACTS

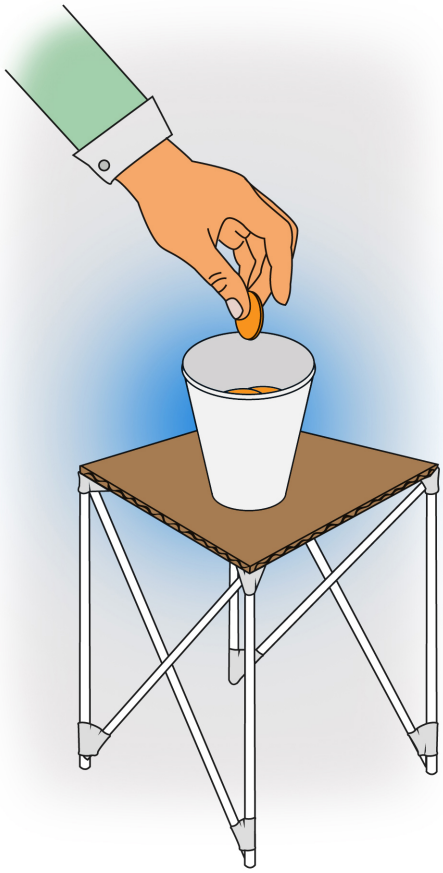


It's true!

- The 70 t SLS will weigh almost as much as 8 fully-loaded 747 jumbo jets, and it produces as much thrust at launch as 135 jet engines.
- The Mars Curiosity rover is about the size of a Mini-Cooper. The 70 t SLS can launch 70 Curiosity rovers at the same time.
- You can fit 9 fully loaded school buses into the 130 t SLS.
- The 130 t SLS will create as much horsepower as 17,400 train engines.

Light but **Strong**

student journal notes



Your Challenge

To design and build a mobile launcher platform that will hold as much weight as possible.

Think it over

Your platform must be both light and strong.

Discuss with your group:

- What does it mean for something to be light weight?
- What does it mean for something to be strong?

The core stage of the SLS will be made from a light and strong material called aluminum.

Name one thing that you know is made of aluminum.

_____

Name two items that are light but also strong.

_____

_____

Plan and design

Your platform must hold the rocket (a cup) six inches above the ground. The platform must also be able to be moved to the testing site and hold a 3" by 3" piece of cardboard.

Discuss with your group how you will build your mobile launcher platform.

- Which materials will you use?
- What will your platform look like?
- What type of material will you use to hold the platform together?

Draw a picture of your proposed platform:

Build

Collect all of the materials to begin building your platform.

Did you use all of your materials? Yes ____No____

Did you change your original design as you were building? Yes ____No____

Why?_____

Testing and results

Now that you have finished building your mobile launcher platform, it is time to test how much weight your platform can hold.

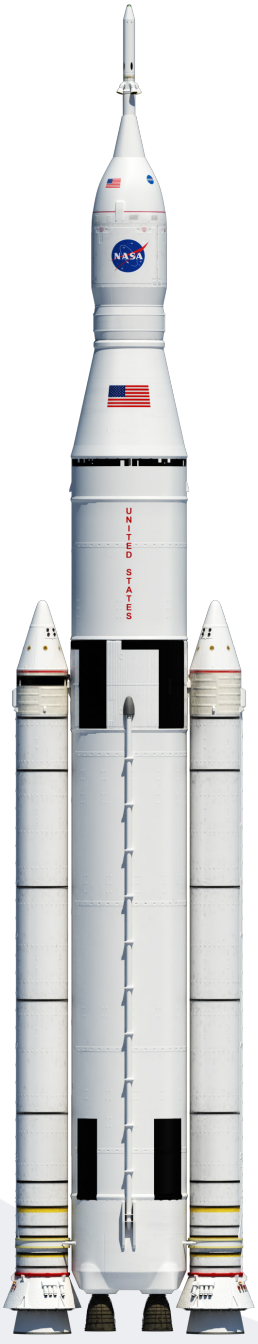
Move your platform to the testing area.

Estimate how many pennies your platform will hold.	**How many pennies did your platform hold?**

If you did this activity again, would you change your design? Yes ____No____

Why?_____

Light but **Strong**



SLS 70-metric ton vehicle

SLS 130-metric ton vehicle

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